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Original communication

Soft tissue thickness in young north eastern Brazilian individuals with different skeletal classes

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ABSTRACT

The aim of this study was to evaluate the variation in facial soft tissue thickness in young north eastern Brazilian individuals according to gender and skeletal class. Measurements were obtained from digitized teleradiographs of 300 children, aged from 8 to 12 years, using the Sidexis Xg program. Data of mean, standard deviation, maximum and minimum soft tissue thickness values of the faces of Angle's Class I, II and III individuals, were evaluated. The results demonstrated that there was no difference in soft tissue thickness among the skeletal classes for most of anthropological points. For the Class I, statistical differences were found ($P < 0.05$) between the genders in the rhinion point, subnasal and upper lip. It was concluded that there was no difference in soft tissue thickness among the skeletal classes, except between Class II and III for the points: Stomion, Bottom lip and Pogonion, allowing definition of parameters of this population for the purpose of facial reconstruction.

1. Introduction

According to the Interpol guidelines for the identification of victims of mass disasters, in addition to being reliable and capable of being applied under conditions in the field, the methods of identification must be of a scientific nature.[1,2] The primary methods are papiloscopic analysis, comparative dental analysis and DNA exams. These are considered positive techniques, as they allow the individualization of a person, differentiating him/her from any other person.[3]

Secondary methods of identification include the description of personal characteristics, medical findings, clothing, anthropological studies, and facial reconstruction. They serve to support the process of establishing identify, and are considered presumptive techniques, as they allow a suspect to be excluded or not, but do not positively establish identity.[3]

When the remains of a cadaver are discovered after some time, facial characteristics may be presented in such a distorted form (or be absent), which makes it impossible to determine identity. Various attempts are made to identify a body, based on characteristics such as age, sex, race, stature and marks of lesions on bones.[4,5]

In some cases, distinctive characteristics of the deceased, such as polydactyl, old fracture calluses, the presence of an extra rib (cervical or lumbar) may also help in identification. These resources are useful, but do not specifically indicate that the cranium in question discovered definitely belongs to a particular person.[4,5]

In situations in which the identity of a cadaver is unknown, and especially in cases in which there are no suspects, methods such as facial approximation may help to resolve many impasses during the investigation of identity.[6] Facial reconstruction is applicable in cases in which the process of soft tissue decomposition is complete or nearing completion.

The end purpose of reconstruction is to recreate a face sufficiently similar to the one the individual had while alive, to the point of allowing a relative to recognize it.[6]

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Contemporary facial reconstruction techniques include bidimensional or tridimensional manual, and tridimensional computerized techniques. Basically, the techniques consist of defining the depth of soft tissues in specific points of the cranium, design of the facial musculature, and determining the facial morphology.[6,7]

For definition of the depth of soft tissues in specific points of the cranium tables drawn up on the basis of population studies are used. The literature points out that these methods vary according to the ethnic group, gender and age. Nevertheless, their reliability may be prejudiced by the lack of records about the thickness of soft tissues in a specific population.[8] From this aspect, the aim of the present study was to evaluate the variation in facial soft tissue thickness in young north eastern Brazilian individuals according to gender and skeletal class.

2. Material and methods

With the purpose of obtaining the thickness of patients' soft tissues, an exploratory study with a descriptive experimental approach was developed after it was approved by the Ethics Committee for experiments involving humans – UESB, protocol CEP/0101102, in accordance with The Code of Ethics of the World Medical Association. A selection was made of 340 digital lateral teleradiographs obtained from the same radiologic center, of healthy children aged from 8 to 12 years, who consulted the Southwest Bahia State University Dental Clinic – UESB. Of these, 40 were excluded from the research, as they fell into the category covered by the exclusion criteria (use of fixed appliances and absence of permanent first molar). Therefore, the measurements were taken in 300 images, 48% ($n = 144$) of the male, and 52% ($n = 156$) of the female gender.

After obtaining informed consent from the parents, the digital teleradiographic images were used to evaluate the soft tissue thickness of faces and to classify the patient with regard to occlusal relationship.

Initially the images were classified into three skeletal classes. The types of skeletons were divided on the basis of angle ANB, which indicates the relationship between the position of the maxilla and mandible, measured as follows: (A) the deepest point on the premaxilla outline, (B) deepest point on the anterior wall of the mandibular symphysis and (N), nasion, lateral view of the most anterior point of the frontonasal suture. The three skeletal classes were classified as follows: Class I, angle ANB 2 ± 2°, Class II > 4°, and Class III, angle ANB <0°, with 100 images evaluated for each malocclusion, being: Class I (MALE = 48 and FEMALE = 52) Table 2, Class II (MALE = 50 and FEMALE = 50) Table 3 and Class III (MALE = 46 and FEMALE = 54) Table 4.

After classification, the images were opened in the Sidexis Xg program (Sirona Dental Systems, Bensheim, Germany), which served as a fundamental instrument for exact determination of the soft tissue thickness of each individual from the digital teleradiographs. The images were positioned in the program with the head facing forward and Frankfort horizontal plane parallel to the ground.

The image was handled carefully to prevent distortion of the soft tissues and had a standardized 2.150 × 2.378 pixel resolution and 24-bit depth.

The distance between the bony structures and the soft tissue was measured for each for the following anthropological points: (1) glabella; (2) nasion; (3) rhinion; (4) subnasal; (5) upper lip; (6) stomion; (7) bottom lip; (8) labiomental; (9) pogonion and (10) gnathion, respectively (Fig. 1 and Table 1).

The points were marked by the operator; the computer then constructed a line between the two points and measured the distance between the skin surface point and the point on the bone surface. These measurements were determined with the aid of the "analysis" sector, using "measure length" as the drawing tool available in the Sidexis Xg program. It should be pointed out that all the measurements were taken by the same, previously calibrated operator, for demarcation of the anthropological points and analysis of measures (Kappa = 0.79). The technical error of measurement (TEM), the relative error of measure technique (rTEM), and the coefficient of reliability (R) were performed to assess the accuracy[9–12] of this study. TEM is interpreted as the typical magnitude of error associated with a certain measurement and can be used to estimate inter and intra-observer precision. rTEM represents an estimate of error magnitude as a percentage of object size. According to Pedersen and Gore[13] the relative error of measure technique (rTEM) must be less than or equal to 5% to be considered

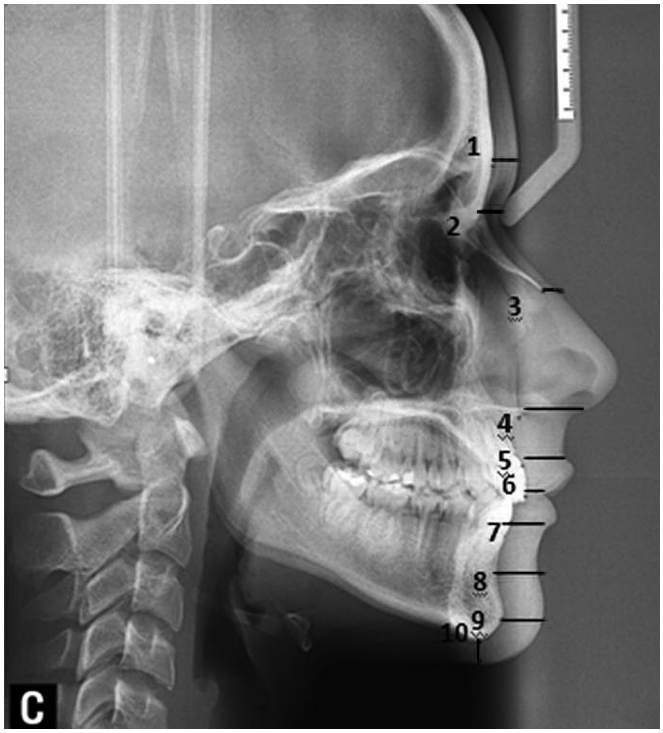

Fig. 1. Location of points used for measuring facial soft tissue thickness: (1) glabella; (2) nasion; (3) rhinion; (4) subnasal; (5) upper lip; (6) stomion; (7) bottom lip; (8) labiomental; (9) pogonion and (10) gnathion.

Table 1
Concepts with reference to structures traced and used.

Concepts	
1. Glabella	Area from the most prominent point between the supraorbital crests to the corresponding soft tissue.
2. Nasion	Area from the midpoint between the frontal bone and orbital nasal bones to the corresponding soft tissue.
3. Rhinion	Anterior point of the nasal bones
4. Subnasal	Area from the most prominent point of the anterior nasal spine to the corresponding soft tissue.
5. Upper lip	Area from the most internal region to the most external region of the upper lip.
6. Stomiom	Area from the midpoint of the oral cavity to the corresponding soft tissue.
7. Bottom lip	Area from the most internal region to the most external region of the bottom lip.
8. Labiomental region	Area from the point below the bottom lip to the corresponding soft tissue.
9. Pogonion	Area from the most prominent point of the mandibular symphysis to the corresponding soft tissue.
10. Gnathion	Area from the most inferior point of the mandibular symphysis to the corresponding soft tissue.

Table 2
Technical error of measurement (TEM), relative error of measure technique (rTEM) and coefficient of reliability (*R*) for each soft tissue thickness measure.

Points	TEM	rTEM (%)	*R*
1. Glabella	0.11	4.91	0.995
2. Nasion	0.10	4.18	0.993
3. Rhinion	0.06	4.55	0.984
4. Subnasal	0.30	3.90	0.999
5. Upper lip	0.27	3.65	0.999
6. Stomion	0.12	4.11	0.995
7. Bottom lip	0.26	3.85	0.999
8. Labiomental region	0.23	3.98	0.998
9. Pogonion	0.22	4.27	0.998
10. Gnathion	0.14	4.53	0.996

TEM scores are expressed in millimeters. rTEM scores are expressed as a percentage of the grand mean.

satisfactory. *R* represents the proportion of between-subject variance that is free from measurement error.[9–12]

After obtaining the results, statistical analyses were performed using the program Statistical Package for the Social Sciences (SPSS) software for Windows (SPSS Inc., Chicago, version 14.0). The Student's-*t* test was used to compare two groups. The ANOVA test was applied to compare more than 2 groups and Tukey's test when there was indication of statistical difference.

3. Results

TEM, rTEM and (*R*) were calculated for each soft tissue thickness measure (Table 2) and considering the facial skeletal pattern and genders (Table 3). The repetition of the measurements for the 10 soft tissue thickness measures (Table 2) demonstrated an acceptable variability to considerer rTEM with values lower than 5% and TEM below 1%. According to the reliability coefficients (Table 2), more than 99% of variations observed in the measurements performed in the 10 soft tissue thickness measures are from external causes (eg, inherent characteristics to their own areas of measurement) different from those associated to the errors of measurement techniques, the same can be observed considering the facial skeletal pattern and genders (Table 3) which showed that at minimum 98% of the variations relating of the measurements are more due to external causes. Taken together, the data evaluated from to TEM and rTEM and *R* demonstrated an acceptable accuracy in this study.

Tables 4–6 present the mean, standard deviation and maximum and minimum soft tissue thickness values of the faces of Angle's Class I, II and III individuals, respectively. Table 4, shows that with regard to skeletal Class I, the data analysis demonstrated statistical differences ($p < 0.01$) between individuals of the female and male gender only for the means obtained at the rhinion ($p = 0.005$), subnasal ($p = 0.001$) and upper lip ($p = 0.001$) points.

In the evaluation of individuals with malocclusion of Class II and III (Tables 5 and 6), no significant difference between the genders was found, with regard to the mean values for the same points evaluated ($p > 0.05$).

Table 7 presents a comparison among the skeletal classes, of the mean facial soft tissue thickness of children. In this table it is noted that there were no significant differences among the classes evaluated, except at the stomion, bottom lip and pognion points. For the stomion there was considerable difference between Class II (11.06 mm) and Class III (17.61 mm) in the male gender ($p < 0.05$); and Class II (11.92 mm) and Class III (16.93 mm) in the female gender ($p < 0.05$). For the bottom lip and pognion, differences were also shown between Classes II and III ($p < 0.05$). For the bottom lip and pognion the values were (30.88 mm and 24.72 mm, respectively) in the female gender, and (23.04 mm and 29.44 mm, respectively) in the male gender.

4. Discussion

The facial reconstruction process is used to investigate human remains that have no attributable identity, allowing an individual's face to be recreated by means of reconstructing the outlines of cranial soft tissues, which increases the probability of facial recognition.[8] All the methods of reconstruction used in forensic anthropology, whether in sculpturing, drawing or assisted by computerized images, are based on the thickness of soft tissues. Therefore, these measurements are indispensable to this process.[4]

To perform this method correctly it is necessary to know the mean thickness of the soft tissue in specific locations of the face. This requires the establishment of a database with regard to the dimension of these tissues in relation to age, gender, race and ethnicity.[14,15] Thus, the purpose of the present study was to verify

Table 3
Technical error of measurement (TEM), relative error of measure technique (rTEM) and the coefficient of reliability (*R*) for each measure, according to the skeletal pattern and genders.

Class	Genders	Test	Points									
			Glabella	Nasion	Rhinion	Subnasal	Upper lip	Stomion	Bottom lip	Labiomental region	Pogonion	Gnathion
I	MALE	TEM	0.13	0.11	0.07	0.31	0.28	0.12	0.27	0.25	0.22	0.16
		rTEM	4.92	4.50	4.95	3.60	4.91	4.30	4.44	3.99	4.39	3.45
		R	0.995	0.994	0.987	0.999	0.999	0.994	0.999	0.999	0.998	0.997
	FEM	TEM	0.12	0.12	0.05	0.25	0.26	0.11	0.25	0.22	0.21	0.15
		rTEM	4.48	3.10	4.38	3.92	4.21	4.42	3.92	3.35	4.21	4.41
		R	0.995	0.994	0.979	0.999	0.999	0.994	0.999	0.998	0.998	0.996
II	MALE	TEM	0.11	0.10	0.06	0.28	0.26	0.10	0.30	0.22	0.21	0.12
		rTEM	4.89	4.45	4.12	3.19	4.44	4.49	3.39	4.11	3.48	4.40
		R	0.993	0.993	0.982	0.999	0.999	0.992	0.999	0.998	0.998	0.996
	FEM	TEM	0.10	0.11	0.05	0.26	0.25	0.10	0.27	0.22	0.19	0.14
		rTEM	4.32	3.78	4.22	3.38	3.96	4.38	3.40	3.75	3.88	4.41
		R	0.994	0.993	0.978	0.999	0.999	0.993	0.999	0.998	0.998	0.996
III	MALE	TEM	0.12	0.09	0.08	0.27	0.24	0.15	0.30	0.26	0.27	0.15
		rTEM	3.22	3.49	4.24	4.61	4.20	3.99	4.65	3.56	4.58	4.40
		R	0.995	0.991	0.989	0.999	0.998	0.997	0.999	0.999	0.999	0.997
	FEM	TEM	0.11	0.11	0.07	0.29	0.24	0.15	0.22	0.20	0.21	0.15
		rTEM	4.71	4.25	4.92	4.43	3.91	3.47	3.95	3.89	3.76	4.91
		R	0.995	0.994	0.986	0.999	0.999	0.996	0.998	0.998	0.998	0.996

TEM scores are expressed in millimeters. rTEM scores are expressed as a percentage of the grand mean.

Table 4
Mean, standard deviation, maximum and minimum facial soft tissue thickness (mm) in children with Class I (Angle).

Points	MALE ($n = 48$)				FEM ($n = 52$)				
	Mean	SD	Max	Min	Mean	SD	Max	Min	*P*
1. Glabella	14.71	3.09	20.04	10.16	13.86	2.47	19.64	10.16	0.351
2. Nasion	13.16	3.23	18.29	9.48	13.04	1.68	16.53	10.16	0.765
3. Rhinion	8.67	1.89	11.51	5.42	6.93	1.75	10.84	4.74	0.005*
4. Subnasal	32.96	3.87	38.61	27.09	27.36	3.54	31.83	17.61	0.001*
5. Upper lip	30.02	4.03	38.6	25.74	27.27	3.23	32.51	23.7	0.001*
6. Stomion	13.17	2	15.58	10.18	12.82	2.61	16.25	7.45	0.593
7. Bottom lip	28.29	4.87	36.57	20.45	27.19	3.06	31.15	21	0.620
8. Labiomental region	26.26	3.7	31.83	21	24.43	4.25	34.54	19.64	0.091
9. Pogonion	24.68	4.52	32.52	16.93	22.59	2.99	28.45	18.29	0.113
10. Gnathion	17.54	1.46	22.35	16.93	16.17	2.37	21	11.51	0.817

P = comparison between means. *Student's-*t* test ($p < 0.01$) for statistical differences between the genders.

the facial soft tissue thickness in children of different skeletal classes, from the north eastern region of Brazil.

In this study, the mean, standard deviation and maximum and minimum facial soft tissue thickness of individuals was evaluated according to the skeletal classification of the facial profile into Classes I, II and III, determining straight, concave and convex facial patterns, respectively.[5,16]

Craniometric analyses are performed and interpreted by means of the location of anatomic points and determination of anthropometric measurements that have been established in the literature. These are generally obtained simply with a ruler, pachymeter and other specific electronic appliances.[17]

When comparing the mean results among the skeletal classes, which were presented in Table 7, it is perceptible that there are no significant differences among the classes evaluated, except at the stomion, bottom lip and pognion points. Class I and II present more similar thicknesses between them than Class III. The stomion measures shown to be greater in both genders and the bottom lip measure smaller for female genre in the Class III, these results are directly related to facial compensation of these measures due to mandibular protrusion observed in these patients. The pogonion measure demonstrated is greater in Class III for males, which may be related to the genetic condition of the mandibular prognathism for this genre.

When comparing the results of this study with others in the literature,[18,19] Brazilian children presented a greater facial soft tissue thickness than that of other races that have been the focus of assessment, namely white Americans, Negroes[18] and Hispanic persons[19] at all the measurement points. The soft tissue thickness of Brazilian children was significantly higher, even considering the 10% difference that represents the magnification error of the teleradiographs,[20–22] which was taken into account when compared with other studies.

Moreover, when correlating the results of this article with those of Dumont,[18] the thickness, especially in measurements of the bottom lip, labiomental region and pognion, is significantly greater in Brazilian children than it is in white American children. Of the associated studies, Utsuno et al.[4] was the one that presented results that were most similar to those of the present study. The Japanese are closer to Brazilians as regards facial soft tissue thickness, when compared with other races.[18,19] In the Brazil, anthropological types have been classified into four groups: leucoderms; faioderms; xantoderms and melanoderms.[8] The results of this study demonstrated similar measures to measures of the Asian population,[4] which is linked to the fact that this region of Brazil has a large population xantoderma who have origins in native Indians and immigrants of Asian origin with yellowish skin color, dark and smooth hair, dark eyes, oblique eyelids, a wide face and brachycephalic.

When considering the measures, it is suggested that the use of the mean thickness of the three skeletal classes for points where no statistical differences were observed, could facilitate the work of facial reconstruction.[5,23] On the other hand, the use of a measure of thickness for each skeletal class is indicated at points for which there is statistical difference in thickness. The results indicated that facial soft tissue thickness in children from the north east of Brazil, with Class I, II and III skeletal patterns were similar in both genders for most anthropological points. In the Class I, the results demonstrate that despite the soft tissue thickness measures of the female subjects showed values lower than the male genre, the rhinion point, subnasal and upper lip were significant statistically, the that demonstrates the specific importance of these measures for facial reconstruction and differentiation in the female genre.

The present study presents more faithful results when compared with others that used analogical images, the measurements were taken by means of the Sidexis Xg program in digital

Table 5
Mean, standard deviation, maximum and minimum facial soft tissue thickness (mm) in children with Class II (Angle).

Points	MALE ($n = 50$)				FEM ($n = 50$)				
	Mean	SD	Max	Min	Mean	SD	Max	Min	*P*
1. Glabella	12.05	1.61	15.58	8.13	12.91	2.82	27.11	7.45	0.953
2. Nasion	11.72	2.28	18.29	7.45	12.03	2.27	16.25	8.13	0.267
3. Rhinion	7.52	2.07	13.55	4.74	6.81	1.41	10.16	4.06	0.087
4. Subnasal	30.07	3.32	39.28	23.03	28.72	3.92	37.25	20.32	0.060
5. Upper lip	27.97	4.0	37.25	20.32	27.03	4.12	37.93	18.96	0.238
6. Stomion	11.06	2.79	16.93	6.1	11.92	3.66	25.06	5.42	0.224
7. Bottom lip	32.19	3.9	40.64	25.74	30.88	5.31	45.38	20.32	0.268
8. Labiomental region	24.17	3.46	31.15	19.64	23.94	4.21	33.19	13.55	0.965
9. Pogonion	23.04	4.53	34.54	14.9	23.54	4.66	37.93	12.19	0.317
10. Gnathion	15.75	3.39	23.7	10.84	16.55	3.49	26.41	10.16	0.327

P = comparison between means. Student's-*t* test ($p < 0.05$) no statistical differences between the genders.

Table 6
Mean, standard deviation, maximum and minimum facial soft tissue thickness (mm) in children with Class III (Angle).

Points	MALE ($n = 46$)				FEM ($n = 54$)				
	Mean	SD	Max	Min	Mean	SD	Max	Min	*P*
1. Glabella	14.8	2.06	17.9	11.9	13.71	1.64	16.25	12.19	0.468
2. Nasion	10.69	1.70	13.85	8.95	13.03	1.56	14.9	10.84	0.277
3. Rhinion	9.45	2.11	12.45	6.48	8.58	1.77	10.84	6.1	0.480
4. Subnasal	28.51	2.32	35.77	24.17	33.01	2.24	36.57	30.48	0.147
5. Upper lip	25.74	1.23	28.74	22.74	26.41	1.01	27.77	25.06	0.468
6. Stomion	17.61	3.69	22.61	12.61	16.93	3.38	21.67	13.55	1.00
7. Bottom lip	31.62	3.23	35.90	20.60	24.72	2.65	27.77	20.32	0.157
8. Labiomental region	28.61	3.02	32.80	17.10	22.51	2.43	26.41	19.64	0.157
9. Pogonion	29.44	2.99	34.10	19.20	24.38	2.42	28.45	21.67	0.157
10. Gnathion	18.92	3.47	23.80	12.90	16.67	2.3	21.32	13.55	0.480

P = comparison between means. Student's-*t* test ($p < 0.05$) no statistical differences between the genders.

images, which allow better visualization and image quality; greater precision, thus avoiding operator subjectivity, and particularly, precision and ease with marking the anatomic structures and radiographic points.[22] Cephalometric radiographs provide an increase of approximately 10% in the real size, and can demonstrate the relationship between soft and hard tissues.[20] Enlargement may be ignored without harming the angular measurements, superimpositions of serial tracings and the relationships of linear measurements. It is necessary to correct the measurements only in order to obtain absolute linear values,[21] and this has been corrected in this study for individual linear measurements.

It is well known that this limitation does not compromise progress of the work, as the object is not only to define values, but to analyze and compare the differences between the facial classes in the values that refer to the facial soft tissue thickness in children, for the purpose of assisting for a more precise facial reconstruction process.

5. Conclusion

By conducting this study, it could be concluded that:

- there is no difference in soft tissue thickness among the skeletal Class types evaluated, except between Class II and III for the anthropological points: Stomion, Bottom lip and Pogonion.
- as regards gender, there was also no statistical difference, except for skeletal Class I in the following anthropological points: rhinion, subnasal and upper lip.

Table 7
Mean facial soft tissue thickness (mm) in children with Class I, II and III (Angle).

Points	Mean					
	Class I		Class II		Class III	
	MALE	FEM	MALE	FEM	MALE	FEM
1. Glabella	14.71	13.86	12.05	12.91	14.8	13.71
2. Nasion	13.16	13.04	11.72	12.03	10.69	13.03
3. Rhinion	8.67	6.93	7.52	6.81	9.45	8.58
4. Subnasal	32.96	27.36	30.07	28.72	28.51	33.01
5. Upper lip	30.02	27.27	27.97	27.03	25.74	26.41
6. Stomion	13.17	12.82	11.06*	11.92**	17.61	16.93
7. Bottom lip	28.29	27.19	32.19	30.88*	31.62	24.72
8. Labiomental region	26.26	24.43	24.17	23.94	28.61	22.51
9. Pogonion	24.68	22.59	23.04*	23.54	29.44	24.38
10. Gnathion	17.54	16.17	15.75	16.55	18.92	16.67

ANOVA test followed of the Tukey's test post Hoc ($p < 0.05$) for statistical differences between the Class types evaluated. *Stomion, $p < 0.05$ compared to group male, Class III. **Stomion, $p < 0.05$ compared to group female, Class III. *Bottom lip, $p < 0.05$ compared to group female, Class III. *Pogonion, $p < 0.05$ compared to group male, Class III.

Ethical approval
None.

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Conflict of interest
The undersigned author transfers all copyright ownership of the manuscript "**Soft tissue thickness in young north eastern brazilian individuals with different skeletal classes**" to Journal of Forensic and Legal Medicine in the event the work is published. The undersigned author warrants that the article is original, is not under consideration for publication by another journal and has not been previously published. Moreover, the authors claim that there is no conflict of interest in this study. I sign for and accept responsibility for releasing this material on behalf of any and all co-authors (Matheus Melo Pithon, João Pedro Pedrosa Cruz, Débora Laís Rodrigues Ribeiro).

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